Final Report

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Basic Research for AOARD 104092 "Evaluation of laser oscillation property in wave guide polycrystalline ceramic”

by
Dr. Tomosumi Kamimura

Osaka Institute of Technology,
5-16-1 Ohmiya, Asahi-ku, Osaka 535-8585, Japan

Submitted to
Dr. Kumar Jata, Program Manager

Asian Office of Aerospace Research & Development (AOARD)
7-23-17 Roppongi
Minato-ku, Tokyo 106-0032
TEL:(03)-5410-4409 FAX:(03)-5410-4407

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Tomosumi Kamimura

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14. ABSTRACT
The laser characteristics of waveguide sample manufactured by World Laboratory Co., Ltd. were evaluated. Maximum output of 120 W was obtained from approximately 264 W of absorbed power. Greater than 50% slope efficiency was achieved?the target of in this effort--without cracking the sample. However, in the region with 264 W or more absorbed power, saturation of the output power occurred. The saturation of this output is thought to be caused by a thermal cooling factor. To obtain higher output power, introducing a high-power sample cooling system is indispensable. Oscillation experiments of still-higher output are planned for a follow-on series of experiments.

15. SUBJECT TERMS
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1. <u>SUMMRY of PREVIOUS RESULTS</u>

The laser characteristics of waveguide ceramic sample manufactured by Dr. Ikesue of World Laboratory Co., Ltd. were evaluated with grant "Basic Research for AOARD 104045. The waveguide sample of the 32mm length was prepared for the evaluation for the side-pumping excitation. Current maximum output 62W was obtained from approximately 150 W of absorbed powers. Over 50% of slope efficiency was achieved. The crack of the sample and thermal saturation of the output power cannot be confirmed in this experiment. The oscillation experiment of higher output is going to be performed in this grant.

2. <u>TRAGET of RESERCH</u>

Waveguide type laser oscillation

A side-pumping system is used for an oscillation test. Stacked LDs (808nm) of the maximum output 432W is prepared for this purpose.

[Merit of side-pumping system]
(1) It is suitable for pumping with a long core.
(2) High efficiency (optical-optical) can be acquired.
(3) The laser beam of the excellent quality is obtained.

[Sample condition]
(2) Advanced waveguide type using composite core layer
Size:1.2 x 10 x 32mm
Core doping concentration:0.6at%
Core thickness:0.4mm

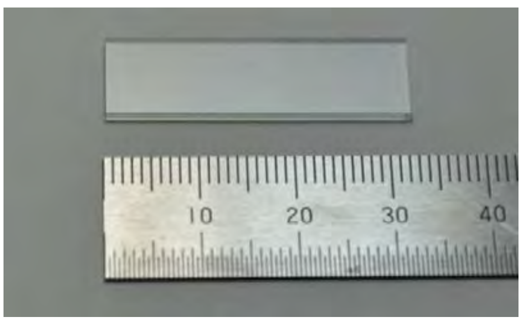
[Performance goal]
Slop efficiency: over 50%
Beam quality: Good

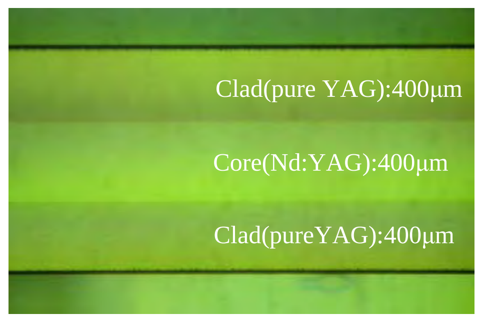
<u>Budget Summary</u>

Sample Type	Output Pomp Power	Schedule	Budget
Waveguide/Adv. waveguide	50W	achieved	25k
	100W	Apr.15	

3. EXPERIMENTAL RESULTS

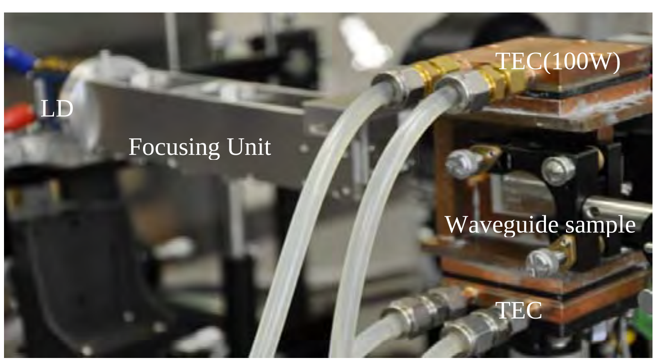
The sample of the 32mm length was prepared for the evaluations of the possibility of the side-pumping (Fig. 1a). All of sample was manufactured by Dr. Ikesue doctor of world laboratory Co., Ltd. A laser active layer (e.g., Nd:YAG with 400μm thickness) is arranged at the center, and low refractive index materials (high thermal conductive material: pure YAG) is strongly bonded at the atomic level on both faces of it. Each thickness of pure YAG is over 400μm thickness. As a result, the thickness of the whole sample becomes 1.2mm (Fig. 1b). From a micro photography, the interfacial condition bonded together is excellent. In the side of the sample (10mm x 1.2mm), gradient processing (3 degree and 4 degree) is taken for ASE prevention. Sapphire was placed outside them more to make pump beam have total internal reflection (TIR). Power density of the pump beam determined the thickness of YAG and the Nd:YAG.

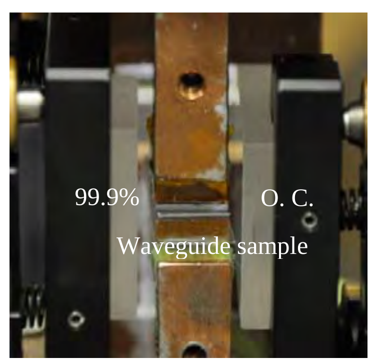




(a) (b)

Fig.1(a) Photograph of the sample with 400μm thickness core, (b) Micro photography of the bonding boundary surface.





(a) (b)

Fig.2(a) Schematic layout of the laser oscillation experiment, (b) Side-view of the sample holder

LD of 808nm was used for a laser oscillation experiment as a pumping laser light. Maximum output of the LDs is 432W. The pumping laser light was incident from edge face of 1.2mmx10mm of the sample. A sample of 32mm propagates as parallel beam by collimating to 8mm width with a focusing unit. A vertical focusing condition was adjustable from 400μm to 1000μm. The sample was attached in a copper heat sink by using heat conduction grease. The heat sink cooled off in two thermo-electronic cooler (TEC: 100W). AR coating was coated for all the edge face of the sample. The sample was put between two flat mirrors and constituted a resonator. The mirror of 20% of transmittance was selected as an output coupler (O. C.). The resonator length was approximately 13mm. In this condition, input power 10% or more become the transmitted leak power. The most of the output are fixed by length of around 10mm, but the remaining part contributes to output, too.

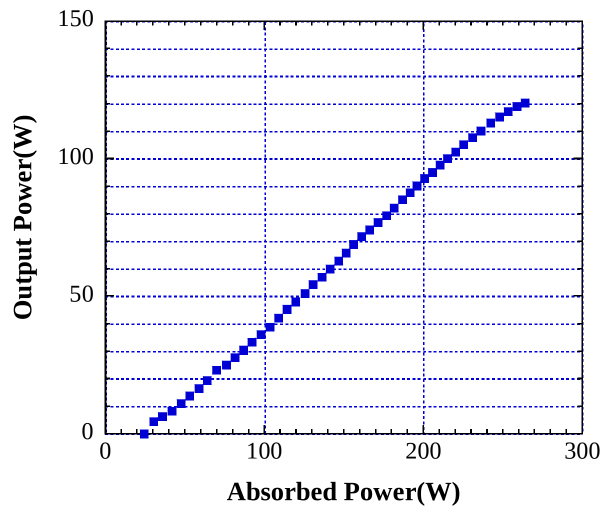


Fig. 3. Relationship between absorbed power and output power for side-pumping experiment.

Relationship between absorbed power and output power is shown in figure 3. The laser output was taken out from the surface of 1.2mm x 32mm. As absorbed powers increased, the laser output rapidly increased. At the region with 80W or more absorbed power, output power almost increases in linear shape. Maximum output 120W was obtained from approximately 264 W of

absorbed powers. Over 50% of slope efficiency was achieved without cracking the sample. However, in the region with 264W or more absorbed power, saturation of the output power occurred. The saturation of this output is thought to be caused by a thermal factor. The balance of occurrence of thermal saturation and the cooling of the heat are as follows. The heat conduction loss from a sample in the sample holder cannot be measured. However, coolability is thought to be just short at the maximum output of 120W. To obtain higher output power, introducing the high-power sample cooling system is indispensable.

Absorbed power (264W) – Output power (120W) > Cooling power (200W) – thermal conduction loss

4. CONCLUSIONS

The laser characteristics of waveguide sample manufactured by Dr. Ikesue of world laboratory Co., Ltd. were evaluated. Maximum output 120W was obtained from approximately 264 W of absorbed powers. Over 50% of slope efficiency was achieved (target of in this grant) without cracking the sample. However, in the region with 264W or more absorbed power, saturation of the output power occurred. The saturation of this output is thought to be caused by a thermal cooling factor. To obtain higher output power, introducing the high-power sample cooling system is indispensable. The oscillation experiment of higher output is going to be performed in other grant “Basic Research for AOARD 114005 "Evaluation and understanding of the laser oscillation property in waveguides"”.